HISTORICAL RÉSUMÉ OF THE EFFORTS MADE TO DEMONSTRATE THE PRACTICABILITY OF THE REACTION BREAKWATER AT ARANSAS PASS, TEX., WITH RESULTS TO FEBRUARY, 1899.

BY LEWIS M. HAUPT.

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(*Read October 6, 1899.*)

NECESSITY FOR IMPROVED METHODS.—Inasmuch as this Society has already set its seal of commendation upon a new method proposed nearly thirteen years ago for the alleviation of ocean bars, it becomes a pleasure to complete the record to date by a brief recital of subsequent events. For some years prior to the filing of the theses, for investigation, in the spring of 1887, I was impressed with the serious obstructions and dangers to commerce due to the prevalence of sand bars on alluvial coasts and the unsatisfactory as well as expensive methods in vogue for their improvement.

In fact, the only harbors of importance on our Atlantic and Gulf seaboard which admitted vessels of over seventeen feet draught at M. L. W., south of New York, were Philadelphia, Baltimore, Norfolk, Port Royal, Pensacola and New Orleans, only six in a coast line covering about 3200 miles. The ruling depths on the bars in many of the other inlets was limited to from eight to twelve feet.

The methods of improvement in general use by maritime engineers to-day are the building of two parallel or convergent jetties for the purpose of concentrating the ebb currents upon that portion of the bar included between them and dredging a channel through this protected area, involving large expenditures for construction and maintenance.

HISTORY.—To remove these barriers from our doors a critical examination was made of a large number of special cases both at home and abroad and by comparative studies of local effects, combined with the operation of the general laws of tides and currents, certain deductions were reached as to the causes operating to produce them. These deductions were formulated in the paper entitled "The Physical Phenomena of Harbor Entrances," submitted to the Society in April, and for which there was awarded the highly esteemed Magellanic premium on December 16, 1887.

Encouraged by this substantial recognition of the merits of the invention, I had the honor to submit the plans to the Board of United

States Engineers having general jurisdiction over river and harbor improvements, in January of the following year (1888), with the view to their introduction by the only parties who could use them. The Board, however, made a report on the 16th of March following, concluding in these words: "The views are purely theoretical, are unconfirmed by experience and contain nothing not already well known, which has a useful application in the improvement of our harbors," thus making a direct issue with the conclusions reached by this Society.

On learning of this report, accidentally, some time later and being anxious to confirm "the views" by establishing a precedent, applications were made to several Chiefs of Engineers in succession, on June 30, July 30 and September 14, of 1888, requesting an opportunity to make a demonstration, but without eliciting any response whatever.

This report of the Board was so directly at variance with the conclusions reached by this distinguished Society, and apparently so erroneous as to the observed movement of littoral drift, that a discussion thereof was carefully prepared and read before this Society on January 18, 1889, under the title, "Discussion on the Dynamic Action of the Ocean in Building Bars."[1]

A copy of this paper was likewise mailed to the members of the Board of Engineers, but elicited no reply. On February 24, 1888, the subject was also presented to the Committee on River and Harbor Improvements of the House of Representatives, attracting much interest and close attention, but no action. Thus the efforts to create additional commercial facilities and to demonstrate the truth of a physical law appeared to be thwarted and there remained nothing to do but to await an opportunity.

This did not occur until 1895, or six years later, when the Government decided to concentrate all the appropriations for the West Gulf coast upon the great problem of creating at least one deep-water entrance at Galveston and abandoned the remaining ports to private enterprise.

Then it happened that Mr. George W. Fulton, President of the Coleman-Fulton Pasture Company, and thoroughly familiar with the conditions at Aransas Pass, Tex., from a residence of over fifty years, and Mr. Brewster Cameron, of Tucson, Ariz., succeeded in persuading the Aransas Pass Harbor Company, holding a franchise

[1] See PROCEEDINGS of March, 1889.

from Congress, to undertake the construction of a breakwater on this plan, after all previous attempts had failed to secure increased depth.

Aransas Pass.—It may be well to state just here that this inlet opens into Corpus Christi, Aransas, Copanio and Nueces bays, covering in all about 350 square miles of tidal waters; that the mean range of the tide of the Gulf is but fourteen inches, and that for many years the pass has been drifting southwestwardly at the average rate of 260 feet per year. It is now about 175 miles west of Galveston; is the point farthest west on the Gulf coast of the United States where it is possible to create an inner harbor, without great cost and has consequently a larger extent of tributary territory than any other Atlantic port, with the important collateral of giving the shortest transcontinental haul. Its position is therefore strategic, and but for the lack of sufficient water on the bar it should long since have become the great metropolis of the Gulf. The controlling natural depths were from six to eight feet on the site of the recent bar, while at Galveston they were twelve and one-half feet, which gave the latter place the precedence and caused the termini of the transportation routes to be located at that point.

Government Efforts.—The superiority of the more western location, however, led the Government to make several vain attempts to secure a navigable channel at Aransas Pass, and as early as January 13, 1853, Lieut. George B. McClellan reported on the pass which was then some two miles east of its present position, and when, in consequence of its steeper slope and more direct discharge, "the depths were about nine feet, but that the channel was constantly shifting." That was a very different pass from the present one and not comparable with it. Fifteen years later (1869) the citizens of Rockport constructed a short wooden spur dike 600 feet long from the shore of St. Joseph's Island on the north side of the pass, which increased the depth two feet, but which disappeared with the destruction of the dike in a few years by storms.

Surveys were renewed by the Government in 1870–71, but no recommendation to improve was made because of the great expense of building a jetty sufficiently strong to withstand the storms of the Gulf because of the alleged existence of quicksands. This it was said was an "insuperable objection to any such experiment." Nevertheless, after eight years more, or in 1879, it was estimated that a channel twelve feet deep might be secured over the bar by

two jetties at a cost of $759,185, and work was actually commenced on this project by the partial construction of the westerly jetty in 1880. The head of Mustang Island was revetted, sand fences built and other work done during the following decade until operations were suspended in May, 1889, after an expenditure of $550,416, with a resulting depth of seven and one-half feet over the bar. In 1887 it was reported to be eight and one-half feet. In the meantime it should be stated that the project was revised in 1887 so as to secure a probable twenty-foot depth. "The original estimated cost of this work as here revised is $2,052,543.72."[1] Work on the Government jetty, which was of mattresses covered with rock, practically ceased about 1885, when it extended seaward including the shore end 5400 feet, and a few years later it was officially reported to have "disappeared," thus confirming the previous opinion as to the difficulties of maintaining such work at that location.

The condition of the bar at the close of the Government work is shown on Plate VI.

Private Efforts.—The years from 1890 to 1895 were spent in experiments by the Harbor Company which was chartered on the 22d day of March, 1890, by the State of Texas, and which secured the passage of an act of Congress, May 12 of the same year, authorizing it to create a twenty-foot channel at Aransas Pass from its own resources. The tribulations of this company and the failure to secure results during the financial depression of those intervening years need not be recorded. Suffice it to say that a contract was made by Mr. Cameron, acting for the Harbor Company, and Charles Clarke & Co., of Galveston, contractors, on the 3d day of July, 1895, to construct only a part of the breakwater on the plans under consideration. The work of placing the foundation mattresses was promptly commenced during the month and vigorously prosecuted. It proceeded so rapidly and was accompanied by such pronounced results that by the end of October it was stated that there were thirteen feet entirely across the bar (see *Report of Board of U. S. Engineers*, Nov. 22, 1897). This without dredging and at an unfavorable season of the year.

Unexpected Obstructions.—It then transpired that the remains of the old Government jetty, which was reported to have "disappeared," were still in place covered with rock, crossing the bed of

[1] *Report of Chief Engineer*, 1887, Part ii, p. 1432.

CONDITION OF BAR OFF ARANSAS PASS AFTER SUSPENSION OF GOVERNMENT OPERATIONS IN 1889.
AUTHORITY, U. S. COAST SURVEY.

the channel and intersecting that portion of the curved reaction breakwater then in place about its middle point (see Fig. 2). It thus acted as a submerged mat or retaining wall to prevent further scour, and as the breakwater subsequently rose, by the deposition of rock, to a plane three feet above the surface a perfect *cul de sac* was formed for the accumulation of sand. The Harbor Company was strenuously urged to remove the obstructing jetty, the existence of which was not suspected, as soon as discovered, but as it had made no provision for this unexpected work either financially or in the contract it was not removed. In consequence a shoal formed reaching to within six and one-half feet of the surface.

The Goodyear Contract and Suspension of Work, May, 1897.—This so discouraged the Harbor Company that it was willing to enter into a contract, dated September 12, 1896, with Col. C. P. Goodyear, of Georgia, to complete the entire work and furnish the capital as per an amended agreement dated March 11, 1897. Under these contracts Col. Goodyear exploded 23.350 pounds of dynamite on the old Government jetty and channel between December 18, 1896, and May, 1897, by which he blasted out about 500 feet of the old jetty, thus opening a small breach through which the currents could partially escape seaward, but, being unable to secure the payments, which he had every reason to expect, for work done elsewhere, from the Government, he was obliged to surrender this contract, and since that date, May, 1897, absolutely nothing has been done to create a channel. In fact, so discouraged were the residents of southwestern Texas, as well as the company, that it was decided to request the Government to appoint a Board of Engineers to appraise the work done with a view to its reconveyance to its jurisdiction. Such a Board was appointed by the Honorable Secretary of War June 22, 1897, and submitted its report November 22 of the same year, or only about six months after the work of blasting was suspended, yet it reveals some interesting features to which attention is briefly directed.

Report of the Board U. S. Engineers of 1897.—It states that between October 30 and November 18 there was "only part of one day that satisfactory soundings could be taken on account of the roughness of the water,"[1] and that this examination gave a depth of eight and one-half feet. The map accompanying this report,

[1] *Vide*, p. 3, Doc. 137, H. R., 55th Cong., 2d Session.

however, shows a channel having a least depth of nine and one-quarter to nine and one-half feet across the bar, which is believed to be a greater depth than had ever existed on the bar in this its most unfavorable position. The *Report*, moreover, states:

"The works built and partially built for the purpose of deepening the channel across this bar have produced no greater depths than were found before these works were constructed."[1]

And again:

"There does not seem any probability that the jetty (meaning breakwater), as now constructed, will of itself secure and maintain any considerable increase of depth in a navigable channel of proper width."[2]

It may seem phenomenal, therefore, that where the eight and one-half feet depth was shown in the chart of November, 1897, there were over twenty-two feet in January, 1899, or an increase of thirteen and one-half feet in a period of as many months, a result which is unprecedented in the annals of harbor improvements, and this without dredging or other assistance, save that derived from the half-completed breakwater reacting upon the partially controlled currents escaping through the breach in the old jetty.

On the other hand, the *Report* states (page 14):

"Since the building of the jetty the position of the channel seems to have become more constant, and, as shown in the following table, the width across the bar to have lessened."

The table referred to shows that between February, 1895, or prior to the beginning of the breakwater, and November, 1897, after work was suspended, the bar had been reduced in width as follows: At the twelve-foot contours the distance across from inside to outside was reduced 550 feet, at the fifteen-foot contours 900 feet, and at the twenty-foot contours by 1600 feet. It is added that "the outside slope has changed but little; . . . . the change has been in the advance of the inner contours." Thus showing that the bar had not advanced seaward, but was eroded on its inner scarp, which is a great desideratum in this class of work. Now, the twelve-foot contours are cut through and but a few hundred feet separate the fifteen-foot contours, if indeed they have not disappeared altogether since the last survey, while there were depths on the bar, under the control of the breakwater,

[1] *Vide*, p. 16, *supra*.
[2] *Vide*, p. 15, *supra*.

reaching to twenty-three feet in January last, and which are probably greater to-day.

The *Report* also states that the Harbor Company has expended on the breakwater about $250,000, which, with the cost of previous work and other expenses, amounted to about $525,000; and the President of the Harbor Company, Mr. Thomas H. Franklin, of San Antonio, in his report to the Board, dated as early as September 7, 1896, says, *inter alia*,[1] in summing up:

"Fifth. Sufficient work has already been done at the pass by the company to demonstrate the entire feasibility of obtaining the necessary depth of water by the expenditure of a practically small additional amount, and the Government has therefore had the problem of deep water solved for it at this port."

That this view seems to be accepted in part by the Board of Engineers would appear from its closing remarks, to wit:

"The Aransas Pass Harbor Company, instead of carrying out the Government plan, adopted one entirely in conflict with it." * * * *

And further:

"This Board believes that with a careful study of the problem a plan of improvement can be devised that will give for a reasonable cost quite a good entrance in which a channel of navigable width with twenty-foot depth at mean low water can be maintained by the aid of inexpensive dredging. Such a plan would doubtless remove a small part of the curved breakwater and utilize the balance. It would cost less than the approved (?) Government plan, but it would not be so good."

And the *Report* closes with these words:

"In consideration of all these facts, the Board is of the opinion that the value to the Government of the works of the Aransas Pass Harbor Company for the improvement of Aransas Pass, Texas, is nothing."

The Aransas Pass Harbor Company Surrenders its Property.—In view of this finding of the Board and the urgent desire of the citizens of southwestern Texas to have the work proceed, the Harbor Company generously concluded to transfer all the work on the breakwater to the Government, as a condition precedent to the early prosecution of the work. This was accordingly done on the 27th day of March of this year.

Estimate of Board of 1898 and Action of Congress Thereon.—In the meantime, however, the subject was referred back to a Board

[1] *Vide*, p. 26.

of Engineers by resolution of the Fifty-fifth Congress, third session, which passed the Senate, May 28, 1898, requesting "the Secretary of War to prepare and submit plans, specifications and estimates for the improvement of the harbor at Aransas Pass, Texas."

Two members of the former Board composed the one appointed under this resolution. They reported on December 17, 1898, but the report and estimate were not submitted until the hour of the hearing before the River and Harbor Committee, and then was not read in full. It states that the Board is of the opinion that to secure a 20 foot channel of a width of 150 feet at bottom "it will be advisable to build two parallel jetties and to have recourse to dredging." . . . . Also that "a portion of the old Government jetty and the outer 1000 feet of foundation of the Aransas Pass Harbor Company's jetty must be removed in any case." (See Fig. 1.)

The estimate accompanying this carefully matured plan places the cost of the works at $1,525,000, without provision for maintenance.

Had this plan been adopted it would have destroyed the efficacy of the reaction breakwater almost entirely and would have involved the Government in useless annual expense for maintenance. It was therefore met on the spot by a counter-proposition to complete the existing work as designed, guarantee a twenty-foot channel within two years and secure the Government from loss by filing a large bond of indemnity, conditioned on the payment by the United States of a sum less than one-half the above estimate of the Government's engineers, on the completion of the work. The proposition also included the use of the invention at this place gratis. The committee held it under advisement to be put in legal form, which was subsequently done, but before acting upon it the Government engineers offered to dredge a channel (without guarantees, however, of any kind) for the sum of $100,000. The committee therefore requested my presence when in executive session, and after a brief discussion as to the probable cost of the several parts of the work and the results to be expected therefrom it decided to insert the following item in its bill:

"Improving Aransas Pass, Texas: For *dredging and other* improvement of Aransas Pass Harbor, sixty thousand dollars: *Provided*, That the Secretary of War is hereby authorized to contract for the removal of that portion of the old Government jetty in said harbor from the end nearest the curved jetty constructed by the Aransas Pass Harbor Company to the wreck 'Mary,' in such manner as *to in no wise interfere with*

the curved jetty now located in said harbor: And provided further, That said contract shall not be let by the Secretary of War, nor said work done, until the said Aransas Pass Harbor Company shall have

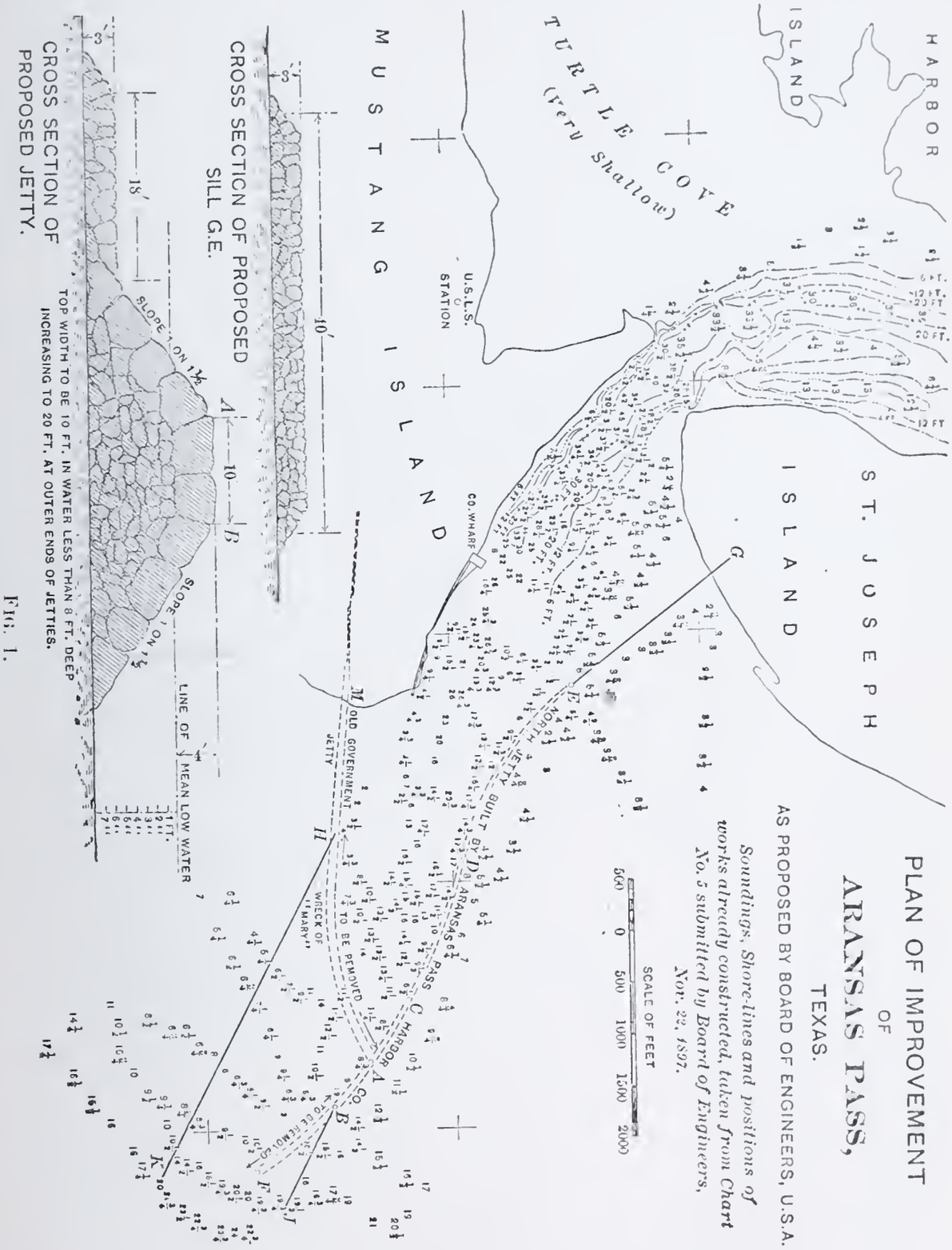


FIG. 1.

properly released and surrendered all rights and privileges heretofore granted to it in said harbor by Congress, also the jetty constructed in said harbor."

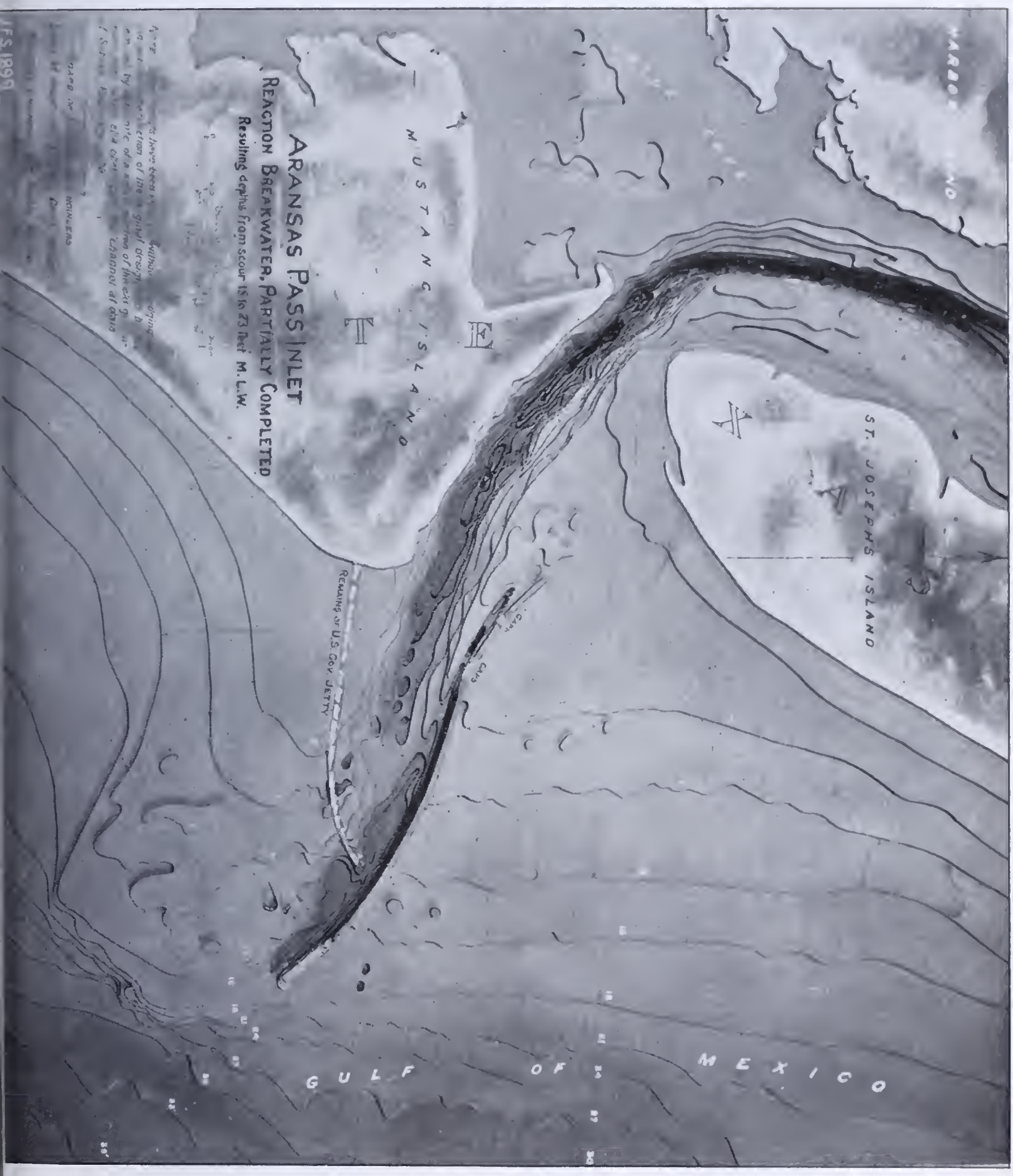
THE PLAN SAVED FROM DESTRUCTION.—Thus the integrity of the invention was preserved for the time being from emasculation, and the Government was saved over $1,000,000 by securing the work done by the Harbor Company, without consideration and by avoiding the unnecessary additional work proposed, the effect of which would have been to obstruct the tidal influx and destroy the natural scour. It should be added that during the consideration of this important subject by both Boards, the Consulting Engineers were given no opportunity to be heard, and did not receive a copy of the reports for months after their presentation to the department.

RESULTS OFFICIALLY REPORTED BY THE COAST SURVEY.—Whilst these matters were pending in Congress last winter the Superintendent of the United States Coast and Geodetic Survey, Dr. Henry S. Pritchett, detailed the survey steamer, "Bache," during January and February to make a detailed hydrographic survey of the bar, but the report thereof showing the remarkable results was not available until the end of June, too late to be of service before Congress.

In this report the assistant in charge of the "Bache," Capt. Welker, stated that the weather was so bad as to prevent work on the bar for more than about one day out of each week and also that

"In 1895 the Aransas Pass Harbor Company constructed a jetty in the shape of the letter 'S,' on the north side of the entrance, which is still in existence, and ever since its construction there has been a marked increase in the depth of water on the bar. The present channel crossed the Mansfield jetty, portions of which are still in existence. An attempt was made to remove this by explosion of dynamite, with the result that the rocks scattered over considerable area and without doubt they prevented the current from scouring the bottom to its full capacity." . . . . "It is my opinion that by the completion of the present jetty and the clearing away of the rock in the entrance that a channel of at least twenty feet in depth would soon be secured."

This rapid and progressive deepening of the channel was known in the neighborhood by report of pilots and by the draft of vessels entering the Pass, but does not seem to have merited the attention of the Board in the preparation of its recent plans and estimates. In fact the deepening was so remarkable that many persons were very skeptical as to the facts, and it was therefore necessary to have the official confirmation of the Coast Survey as stated above to verify them.



CONDITION OF BAR AFTER SUSPENSION OF WORK BY THE ARANSAS PASS HARBOR CO.
. COAST SURVEY, FEB., 1899, SHOWING HALF-COMPLETED BREAKWATER AND OBSTRUCTING, SUBMERGED JETTY.

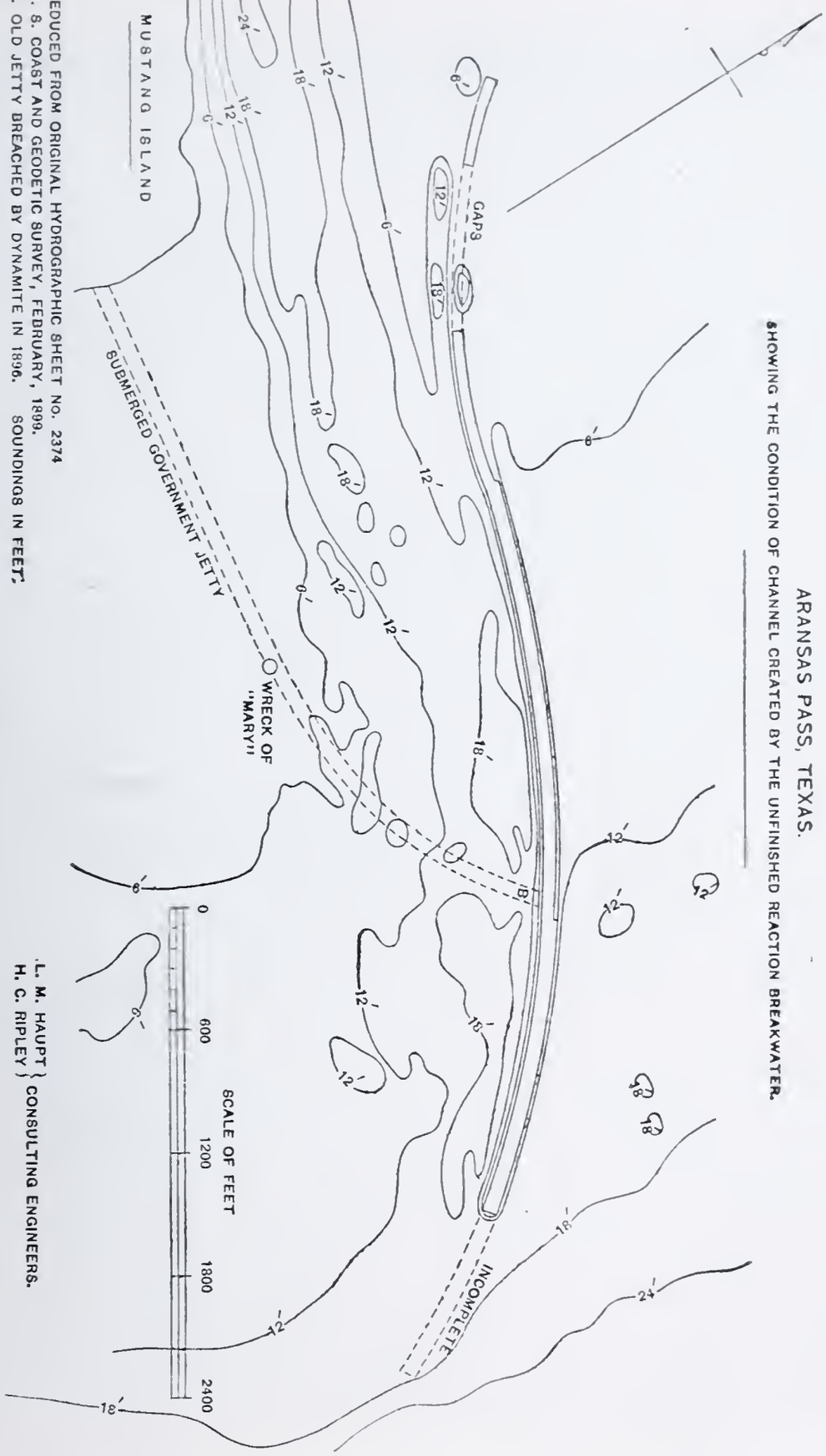


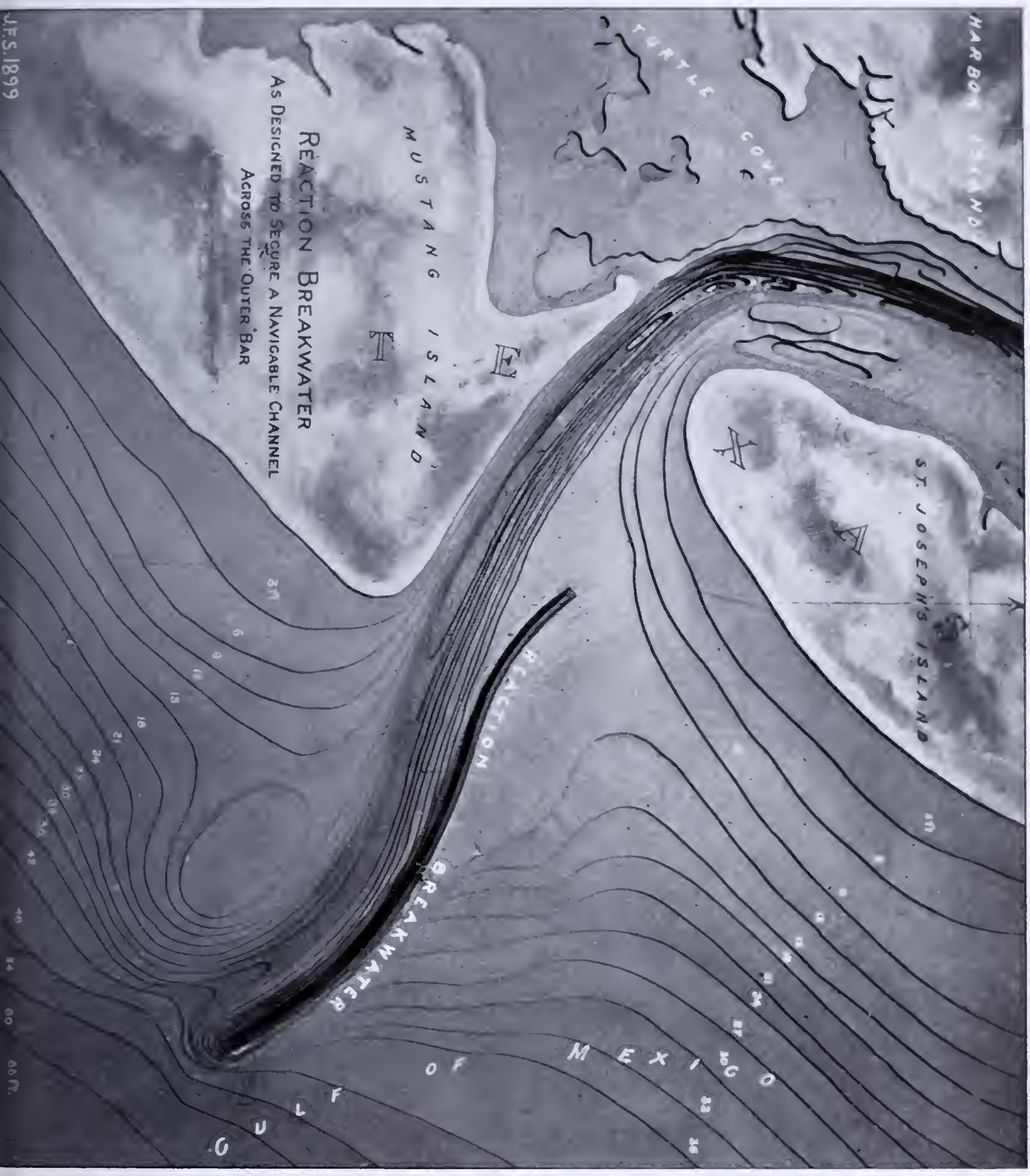
FIG. 2.

THE WORK OF REMOVAL OF THE OBSTRUCTING GOVERNMENT JETTY FINALLY APPROVED AND BIDS INVITED.—The last chapter in

this record is brief, for as yet nothing has been done on the work of removing the obstructing jetty. The act was passed at the close of the last session of Congress, March 4, and after careful and intelligent consideration the Government Engineer of the district, Col. C. S. Riché, son of Prof. George I. Riché, late member of this Society, recommended the letting of the work under the appropriation and provisions as made by Congress. It was authorized July 11, and advertised on September 25 for thirty days, when the bids are to be opened, which brings the chronology of events up to the 30th inst. Additional time will be consumed before the preliminaries are complied with. If there be no bidders, the work must be readvertised. In such case no contractor can transfer a plant to the site much before the winter storms begin which involve serious loss of time and increased cost for the Government, or loss to the contractor. Even after the removal of the old jetty time will be required for the currents to adjust themselves to the new regimen and demonstrate their ability to enlarge the channel. These delays therefore will doubtless retard greatly the development of the channel at this important entrance on the West Gulf coast.

THE PROGRESSIVE DEEPENING PRODUCED BY THE BREAKWATER WITHOUT DREDGING OR OTHER AID.—In conclusion it remains only to state that this half completed, single breakwater has so far controlled the ebb currents as to have removed from the channel by their own energy some 400,000 cubic yards of compact, sandy material, and to have produced a progressive improvement of depths, as follows:

	FEET.
August 28, 1896. After suspension of work on breakwater by company	6.0
December 10, 1896. Before old jetty was breached the depth was	6.5
February 2, 1897. During use of dynamite	8.0
June 8, 1897. After work was suspended	8.75
November 5, 1897. Without further aid from any source.	9.25
February 5, 1898. An examination with lead line gave	10.0
June 15, 1898. Pilots reported	11.0
August 29, 1898. Pilots reported and added, "The S. E. wind this summer did not fill it up as it usually does."	12.0



PROBABLE CONDITION OF BAR TO BE EFFECTED BY THE COMPLETION OF THE REACTION BREAKWATER AND REMOVAL OF OBSTRUCTING JETTY.

	FEET.
January 4, 1899. Telegram announced (on pilot's range)	13.3
February 11, 1899. Capt. Welker wired the Coast Survey office	15.0

Economy and Depths Unprecedented.—So that in two years there was a gain of eight feet produced by a half-finished structure in the face of serious obstructions at a cost of less than $30,000 per foot depth as compared with from $200,000 to nearly $900,000 at other places by the usual twin jetty system. It may therefore be safely stated, even without awaiting the completion of the breakwater and the removal of the obstructing jetty, that as our respected Vice-President, Mr. Coleman Sellers, remarked only last evening in referring to the progress of the Mechanic Arts: "Two blades of grass have been made to grow where one grew before." In fact the adage may be carried further, since in this case the half of a blade (jetty) has done what two complete blades (jetties) have never done before in the same time, without dredging, and the American Philosophical Society has evidently not made a mistake of judgment in awarding its highly prized Magellanic premium and medal for this "invention and discovery."